Zooplankton Abundance and Size in British Columbia Lakes Sampled by the Lake Enrichment Program in 1980

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by

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ABSTRACT

Rankin, D. P. and J. E. Radziul. 1986. Zooplankton abundance and size in lakes sampled by the lake enrichment program in 1980. Can. Data Rep. Fish. Aquat. Sci. 589: 170 p.

Zooplankton samples were collected from 16 lakes in 1980. The purpose of the sampling was to collect data on zooplankton abundance, size and species composition from fertilized lakes and lakes being considered for fertilization under the federal-provincial Salmonid Enhancement Program.

RESUME

Rankin, D. P. and J. E. Radziul. 1986. Zooplankton abundance and size in lakes sampled by the lake enrichment program in 1980. Can. Data Rep. Fish. Aquat. Sci. 589: 170 p.

Des échantillons de zooplancton ont été prélevés dans 16 lacs en 1980. Cet échantillonnage avait pour objectif de recueillir des données sur l'abondance, la distribution des tailles et la composition en espèces du zooplancton de lacs fertilisés ou que l'on prévoit fertiliser dans le cadre du programme fédéral-provincial de mise en valeur des salmonidés.

INTRODUCTION

Samples of zooplankton have been collected from a variety of lakes in British Columbia in each year since 1977 and from lakes in the Yukon in 1977 and 1983 only (see previous reports by Rankin, Ashton and Kennedy 1983, 1984). These samples have been collected as part of the Lake Enrichment Program's studies on the use of nutrient additions to oligotrophic lakes as an enhancement technique for sockeye salmon (Stockner and Hyatt 1984 reviewed the objectives and progress of lake enrichment in the Pacific Northwest). The general purpose of these sampling efforts is to provide data concerning zooplankton abundance, species and size composition in a wide range of sockeye salmon nursery lakes. Information on zooplankton is used to assess, in part, a given lake's suitability for treatment to increase zooplankton food supplies potentially available to juvenile sockeye. During years in which the lake is treated these same data are required as indicators of treatment effects and their potential impact on sockeye growth and survival.

A complete record of the methods and results associated with the analysis of the 1979-80 zooplankton samples has not been produced to date and this is the focus for two reports, the present one and Rankin and Radziul (in prep).

MATERIALS AND METHODS

The locations of the lakes samples are given in Tables 1 and 2. Zooplankton vertical hauls in mid-lake (1 per station) were taken from a float-equipped DeHavilland of Canada "Beaver" aeroplane using a dark 100-um S.C.O.R. net (mouth area = 0.25 m^2). Station locations are given by Costella et al. 1982. The samples were generally taken between 0900 and 1200 h. The net was hauled from 25 m (in most lakes) or 50 m to the surface at approximately 0.5 $m.s^{-1}$. After each haul, the net was rinsed and the sample removed and preserved in a 4% formaldehyde-sucrose solution (Haney and Hall 1973). The filtration coefficient of the net was assumed to be 1.0. The number of trips to each lake and the number of sampling stations on each lake are given in Table 1.

Biomass was measured by the following procedure. Each sample was halved using a Folsom plankton splitter. One-half of the sample was filtered onto a pre-dried, pre-weighed 0.45 um Millipore filter, dried at 90°C for 24 h and its weight recorded as $mg.m^{-3}$. No effort was made to remove large, rare organisms (e.g. chironomid larvae, mysids etc.) that may have added to the weight. This technique is not useful when the samples contain a large amount of algae (usually diatoms). These samples are indicated in Tables 2-24. In these cases all the lengths of all the animals in the subsample were recorded. Wet weights were calculated based on length-weight relationships given in Appendix table 1. Dry weights were then calculated after correlating calculated wet weights and dry weights from 129 uncontaminated samples (r^2=0.7628). The "corrected" values appear in Tables 2-24.

Due to budgetary and manpower restrictions the methods used to analyse zooplankton samples in 1979, 1980 were simplified considerably compared to those used in other years. Prior to 1979 a manual system involving a high degree of effort and expertise in zooplankton species identification was used (e.g. Rankin et al. 1979, 1983). After 1980 an electronic data processing system using a micro computer was installed greatly reducing the effort required to process zooplankton samples. This system was similar to that described by Sprules et al. (1981). The methods used to generate the following data are described below. In the laboratory, an aliquot (usually 1/4 of a sample) was diluted to 300 mL in a round-bottom flask. Four 3 mL subsamples were taken from the flask with an automatic pipette after first thoroughly mixing the contents of the flask. The four subsamples were processed separately under moderate magnification (500 X) but the counts were pooled. The subsampling technique is a modification of earlier techniques in which one subsample (1/150 or 1/50 to 1/100) of the total sample was taken (Rankin et al. 1979; LeBrasseur and Kennedy 1971). The subsamples we pooled generally represented 1/100 of the total sample. We felt that the pooled subsamples were a better representation of the total sample than a single subsample (1/400). An estimation of the variation in the subsampling technique in determining the population size of a group of organisms is provided in Appendix Table 2. Zooplankton were identified to genus, and counted. The lengths of the first 25 zooplankton[1] in each category, except copepod nauplii and rotifers, were measured. Copepods were categorized as adult male or female or copepodite. Length was measured, along the dorsal axis, from the head to the base of the urosome in Calanoids and to the base of the caudal setae in cyclopoids. Calanoid carapace lengths were later converted to total length (i.e. to the base of the caudal setae) using the following formulae:

Diaptomids

$$\text{Total length (micrometer units)} = (\text{metasomal length}/0.691)-1.350$$
$$R^2=0.981,\ n=74$$

Epischura

$$\text{Total length (micrometer units)}=(\text{metasomal length}/0.657)-1.752$$
$$R^2=0.953,\ n=50.$$

Cladoceran length was measured from the head to the base of the tail spine or mucro, along the lateral axis. Lengths were determined using an ocular micrometer and were later converted to microns.

The data are reproduced here in two sets of tables. The first set gives dry biomass, crustacea and rotifer numbers. The second set presents mean length, number measured, standard error of length, density (number per cubic metre) and the standard error of the density estimate. In some cases, the density estimates were recorded but the raw data sheets with the length measurements have been lost. In such cases, the columns containing the mean length, the number measured and the standard error of the length are blank.

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[1]Initially the first 50 zooplankton were measured and these data appear periodically in the tables.

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Table 1. Lakes sampled in 1980.

	No. of stations	No. of trips
Awun	1	3
Babine	5	6
Bonilla[b]	1	7
Curtis	1	7
Devon	1	6
Eden	1	3
Great Central	2	9
Henderson	1	9
Hobiton	1	9
Ian	2	3
Kennedy	2	9
Kitlope[b]	1	7
Long	2	9
Lowe	1	7
Mercer[c]	1	3
Mohun	2	9
Morice[a]	2	6
Upper Mikado[d]	1	1

[a]Latitude: 54°00'

Longitude: 127°40'

Area (km^2): 104

[b]"Special" week-long trips were made to these lakes.

[c]Not fertilized.

[d]Latitude: 53°23'

Longitude: 129°48'

TABLES 2 - 17

Zooplankton biomass and numbers (mg dry wt . m^{-3} and no . L^{-1}). The depth from which the vertical haul was taken is also given.

Table 2. Awun Lake, depth = 25 m.

Date	Biomass	Numbers	Rotifer numbers
May 3	7.3	5.4	0
June 24	59.3	8.1	0.10
September 24	25.4	10.1	0.22

Table 3. Babine Lake, depth = 25 m.

Date	Biomass		Numbers	Rotifer numbers
June 2	77.3	Station 3	124.0	3.25
June 2	50.5	Station 4	38.5	1.01
June 3	41.2	Station 5	20.9	0.27
June 4	83.6	Station 1	38.7	0.84
June 4	18.1	Station 2	25.0	1.12
September 29	24.8	Station 1	15.2	0.61
	79.9	Station 2	22.8	1.9
September 30	52.5	Station 3	17.5	0.85
September 30	48.7	Station 4	8.5	0.45
September 30	-	Station 5	9.7	1.49

Table 4. Bonilla Lake, depth = 25 m.

Date	Biomass	Numbers	Rotifer numbers
May 2	4.5	2.7	0.10
May 29	6.9	2.1	1.47
June 26	16.8	2.8	11.63
July 23	33.5	9.8	15.34
August 24	36.4	11.2	4.35
August 25	179.1	231.9	13.83
August 26**	101.0	36.5	1.94
August 26**	103.4	29.7	1.47
August 26**	97.9	29.4	3.66
August 26**	85.9	26.3	1.30
August 26**	110.5	26.2	3.10
August 27	53.8	15.8	2.67
August 28[a]	58.0	28.2	0.51
August 28[b]	54.1	21.0	0.80
August 28[c]	18.9	17.1	0.62
August 28[d]	33.6	13.7	6.78
August 29	23.5	8.1	1.84
September 26	110.3	45.3	2.30
October 22	113.6	73.0	0.38

[a-d]Stations, see Figure 4, Costella et al. 1982.

**Replicate hauls.

Table 5. Curtis Lake, depth = 25 m.

Date	Biomass	Numbers	Rotifer numbers
May 2	1.0	0.1	0
May 31	2.4	0.8	0.05
June 26	4.7	2.7	1.81
July 23	11.6	5.6	0.30
August 20	11.4	8.4	0.26
September 26	11.3	3.4	0.21
October 22	10.0	3.0	0.11

Table 6. Devon Lake, depth = 25 m.

Date	Biomass	Numbers	Rotifer numbers
May 1	1.4	0.2	0.03
May 28	1.4	0.2	3.09
June 27	4.2	0.6	3.90
July 24	6.1	1.5	1.22
August 20	1.8	0.3	0.18
September 25	5.7	1.7	0.26
October 24	9.9	5.0	0.06

Table 7. Great Central Lake, depth = 50 m.

Date	Biomass	Numbers	Rotifer numbers
	Station 1		
March 18	3.5	3.5	0.13
April 15	1.7	1.7	0.03
May 16	5.0	2.5	0.24
June 13	7.1	2.5	0.77
July 11	9.6	3.9	2.62
August 8	2.1*	4.8	1.00
September 12	6.6	2.6	1.27
October 10	5.1	3.1	0.41
	Station 2		
March 18	2.5	2.2	0.03
April 15	1.3	1.4	0.02
May 16	3.7	1.9	0.17
June 13	6.4	3.2	0.50
July 11	5.3	4.3	1.50
August 8	13.2	4.5	0.94
September 12	8.4	3.4	0.95
October 10	6.0	2.2	0.12

*Corrected for diatom contamination.

Table 8. Henderson Lake, depth = 50 m.

Date	Biomass	Numbers	Rotifer numbers
March 18	3.7	1.5	0.02
April 15	4.0	1.6	0
May 16	2.9*	1.7	0.09
June 13	25.1	1.4	0.03
July 11	8.1	3.1	0.11
August 8	-	4.3	0.17
September 12	3.4*	2.6	0.42
October 10	10.0*	2.9	0.18

*Corrected for diatom contamination.

Table 9. Hobiton Lake, depth = 50 m.

Data	Biomass	Numbers	Rotifer numbers
March 18	11.7	2.3	0.01
April 15	5.6	4.7	0
May 16	7.5	2.9	0.25
June 13	8.3	2.3	0.79
July 11	57.0*	7.4	0.82
August 8	4.8	1.6	0.02
September 12	7.4	1.5	0.23
October 10	6.8	1.6	0.24

*Corrected for diatom contamination.

Table 10. Ian Lake, depth = 25 m.

Data	Biomass	Numbers	Rotifer numbers
		Station 1	
May 3	16.4	7.6	0.32
June 24	24.7	4.3	0.70
September 24	42.4	7.0	0.35
		Station 2	
May 3	2.6	1.3	0.05
June 24	20.1	5.3	0.80
September 24	16.3	2.6	0.37

Table 11. Kennedy Lake, depth = 50 m.

Data	Biomass	Numbers	Rotifer numbers
	Station 2		
March 19	2.2	0.9	0
April 16	2.3	1.9	0
May 15	4.2	2.0	0.22
June 12	7.2	4.2	1.22
July 10	4.2*	7.5	1.13
August 7	0.6*	2.4	0.37
September 11	12.8	4.3	0.15
October 9	5.0	1.9	0.01
	Station 3		
March 19	2.8	0.7	0.01
April 16	3.0	1.5	0
May 15	3.2	1.3	0.14
June 12	18.4	5.7	1.37
July 10	9.4	5.9	0.57
August 7	6.7	1.3	0.05
September 11	4.8	1.3	0.10
October 9	11.9	2.4	0.02

*Corrected for diatom contamination.

Table 12. Kitlope Lake, depth = 25 m.

Data	Biomass	Numbers	Rotifer numbers
April 30	2.2	0.3	0
May 30	1.8	0.1	0
June 28	2.2	0.3	0.19
July 27	2.0	0.3	0
July 28	1.3	0.2	0
July 28[6w]	1.7	0.4	0
July 28[6c]	1.8	0.2	0
July 28[6e]	2.2	0.3	0
July 28[7w]	2.8	0.3	0
July 28[7c]	3.9	0.4	0
July 28[7e]	3.9	0.2	0
July 28[8w]	2.2	0.4	0
July 28[8c]	5.1	0.3	0.01
July 28[8e]	4.2	0.3	0
July 28[9c]	-	0.3	0
July 28[10c]	4.1	0.2	0
Stations 6w-10c were sampled from 30 m (Fig. 13, Costell et al. 1982)			
July 29[a]	4.2	0.4	0
July 29[a]	4.7	0.3	0
July 29[a]	1.7	0.4	0
July 29[a]	4.5	0.4	0
July 29[a]	3.6	0.3	0
July 29[b]	4.1	0.5	0
July 30	2.9	0.4	0
July 30[b]	3.7	0.6	0
July 31	4.8	0.5	0
August 19	5.7	0.1	0
September 23	28.9	5.7	0.18
October 25	3.5	0.6	0.08

[a]Replicate hauls.

[b]Station 2.

Table 13. Long Lake, depth = 50 m.

Data	Biomass	Numbers	Rotifer numbers
		Station 2	
March 21	2.9	1.6	0.25
April 19	3.4	1.6	0.10
May 13	6.4	1.3	0.66
June 10	3.7	0.6	0.53
July 8	0.6	0.1	0.02
August 5	3.6	1.8	0.29
September 9	3.6	1.8	0.22
October 7	3.7	4.9	0.19
		Station 3	
March 21	4.8	1.5	0.77
April 19	4.7	1.8	0.49
May 13	3.0	0.3	1.45
June 10	4.0	0.5	1.10
July 8	3.6	0.2	1.53
August 5	2.8	0.3	0.22
September 9	4.4	1.9	0.18
October 7	6.2	2.6	0.03

Table 14. Lowe Lake, depth = 25 m.

Data	Biomass	Numbers	Rotifer numbers
May 1	3.0	1.3	0.19
May 28	6.8	0.7	0.03
June 27	65.2*	2.0	0.32
July 24	29.3	9.8	0.14
August 20	50.0	17.6	0.40
September 25	12.8	5.8	0.21
October 24	24.2	8.2	0.13

*Diatom contamination.

Table 15. Mercer Lake, depth = 25 m.

Data	Biomass	Numbers	Rotifer numbers
May 3	2.1	0.6	0.02
June 24	3.2	2.5	0.08
September 24	7.4	2.1	0.11

Table 16. Mohun Lake

Date	Biomass	Numbers	Rotifer numbers
	Station 1 (30-40 m)		
March 20	-	12.3	0.37
March 25	9.4	5.6	0.16
April 17	-	3.9	0.41
April 23	12.4	7.2	0.70
May 14	28.2	15.1	1.25
June 5	28.0	12.1	0.58
June 11	54.2	9.0	0.95
June 24	14.3	3.8	0.59
July 9	23.2	2.4	0.60
July 13	6.1	2.2	0.18
July 30	-	1.8	0.20
August 6	11.5	4.3	0.42
August 27	4.5	2.0	0.26
September 10	-	4.4	0.83
	Station 2 (15 m)		
March 25	15.3	6.9	0.59
April 23	35.2	10.0	2.11
June 5	65.5	17.8	2.96
June 24	-	9.04	1.2
July 13	46.8	8.2	0.83
July 30	54.9	21.9	1.36
August 27	46.8	8.0	0.75
October 8	-	8.8	1.28

Table 17. Morice Lake, depth = 25 m.

Date	Biomass	Numbers	Rotifer numbers
		Station 1	
May 27	9.7	3.0	0.78
June 25	17.4	6.2	1.76
July 22	15.3	2.6	2.62
August 21	72.2	4.0	1.82
September 28	30.9	3.8	0.80
October 21	22.4	2.9	0.45
		Station 2	
May 27	4.2	1.5	0.37
June 25	17.3	4.8	1.14
July 22	57.3	14.8	15.41
August 21	25.2	1.6	0.88
September 28	23.2	7.4	1.79
October 21	21.3	4.8	1.57

Zooplankton length and densities do not appear in paper,
but appear in microfiche form at the back of this report.